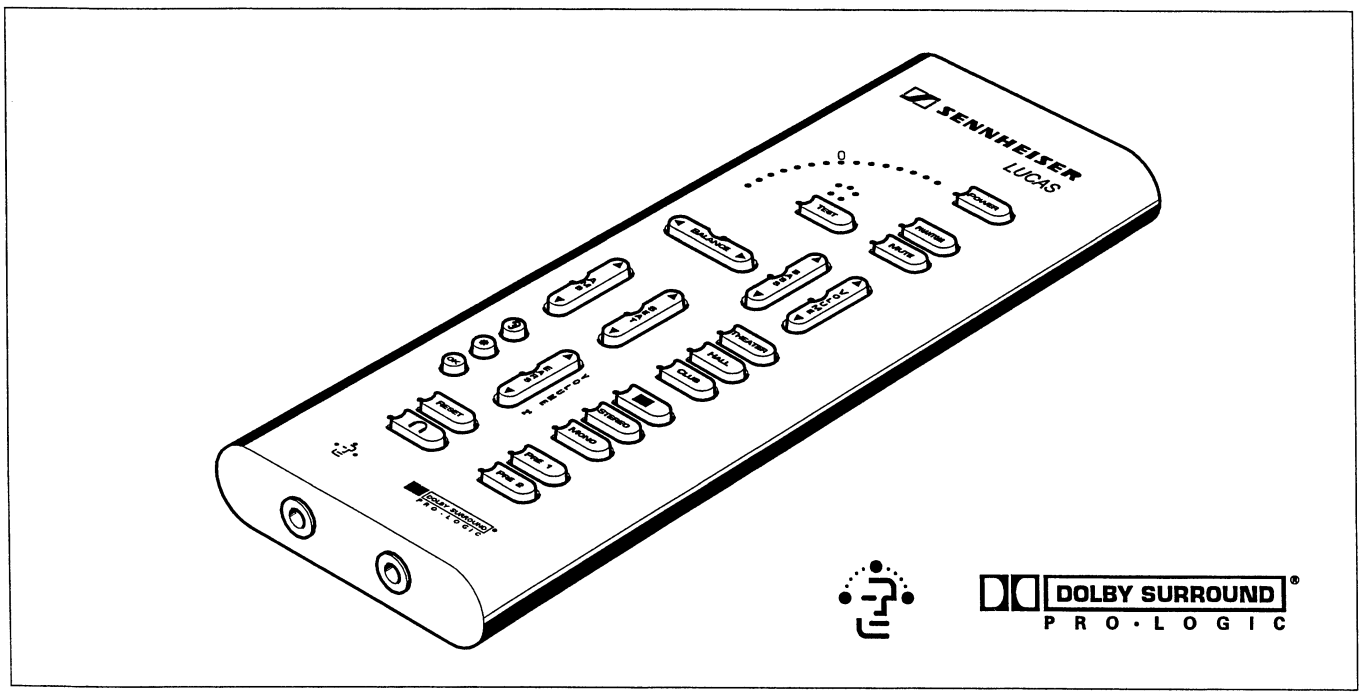
SENNHEISER
Service

LUCAS



BRIEF DESCRIPTION

LUCAS is a headphone preprocessor that creates a surround sound virtual acoustic environment in addition to being a Dolby Pro Logic Decoder. The processing is based on psychoacoustics and digital signal processing technology.

The LUCAS contains a state-of-the-art Motorola DSP56007, a stereo A/D converter, and 2 stereo D/A converters. The digital processing consists of a Dolby Pro Logic Decoder with subsequent convolutions of ten head-related transfer functions (HRTFs) to establish five virtual speakers at the positions left, center, right, and left/right surrounds.

Left and right frontal positions are adjustable to widen or narrow the frontal sound image. In addition, a corresponding adjustment is made to the rear speaker's positions.

To enhance realism and externalization of the virtual speakers, a supplementary room simulation (reverberation with spatial information) is performed.

Three different ambiance types (theater, hall, club) are available and differ in the amount of echo density and reverberation. The 3-D audio processing and virtual acoustics are called Toltec® processing.

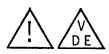
For optimized performance, the LUCAS has to be adjusted for the user's individual HRTFs. For this purpose a matching and selecting procedure can be performed where one out of fifteen possible HRTFs can be chosen. This is done by listening to three short noise bursts and choosing between different HRTFs. If the signal is located in the frontal direction and on the horizon, this HRTF most likely matches your own and should be chosen for presentation.

FEATURES

- VLS Toltec® processing
- Dolby Pro Logic Decoder, including stand-alone mode
- Compact design and small dimensions
- Automatic power-down feature, approximately 2 hours
- Custom cable assembly, easily connects to any stereo source (TV, VCR, etc.)
- Two independent headphone volume controls.
- For use with any standard headphones

Sicherheitsvorschriften / Safety requirements/ Prescrizioni de sicurezza / Prescriptions de sécurité / Prescripciones de seguridad

Deutsch

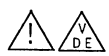


Achtung: Bei Eingriffen in das Gerät sind die Sicherheitsvorschriften nach VDE 701 (reparaturbezogen) bzw. VDE 0860 / IEC 65 (gerätebezogen) zu beachten !

Bauteile nach IEC- bzw. VDE-Richtlinien ! Im Ersatzfall nur Teile mit gleicher Spezifikation verwenden !

MOS - Vorschriften beim Umgang mit MOS - Bauteilen beachten !

English



Attention: Please observe the applicable safety requirements according to VDE 701 (concerning repairs) and VDE0860 / IEC 65 (concerning type of product) !

Components to IEC or VDE guidelines ! Only use components with the same specifications for replacement !

Observe MOS components handling instructions when servicing !

Italiano

Attenzione: Osservarne le corrispondenti prescrizioni di sicurezza VDE 701 (concernente servizio) e VDE 0860 / IEC 65 (concernente il tipo di prodono) !

Componenti secondo le norme VDE risp. te IEC ! In caso di sostituzione impiegare solo componenti con le stesse caratteristiche.

Osservare le relative prescrizioni durante, lavori con componenti MOS !

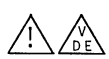
Français

Attention: Prière d'observer les prescriptions de sécurité VDE701 (concernant les réparations) et VDE 0860 / IEC 65 (concernant le type de produit) !

Composants répondant aux normes VDE ou IEC. Les remplacer uniquement par des composants ayant les memes spécifications.

Lors de la manipulation des circuits MOS, respecter les prescriptions MOS !

Español



Atención: Recomendamos las normas de seguridad VDE u otras normas equivalentes, por ejemplo: VDE 701 para reparaciones, VDE 0860 / IEC 65 para aparatos !

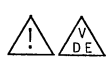
Componentes que cumplen las normas VDE / IEC. En caso de sustitución, emplear componentes con idénticas especificaciones !

Durante la reparacion observar las normas sobre componentes MOS !

USA & Canada

Attention: This set can only be operated from AC mains of 120V / 60Hz. Also observe the information given on the rear of the set !

CAUTION: For continued protection against risk of fire replace only with same type fuses!
CAUTION: To reduce the risk of electric shock, do not remove cover (or back), no user-serviceable parts inside,refer servicing to qualified service personnel.



Components to safety guidelines (IEC / U.L.) ! Only use components with the same specifications for replacement !

Observe by checking leakage-current or resistance measurement that the exposed parts are acceptably insulated from the supply circuit.

Observe MOS components handling instructions when servicing !

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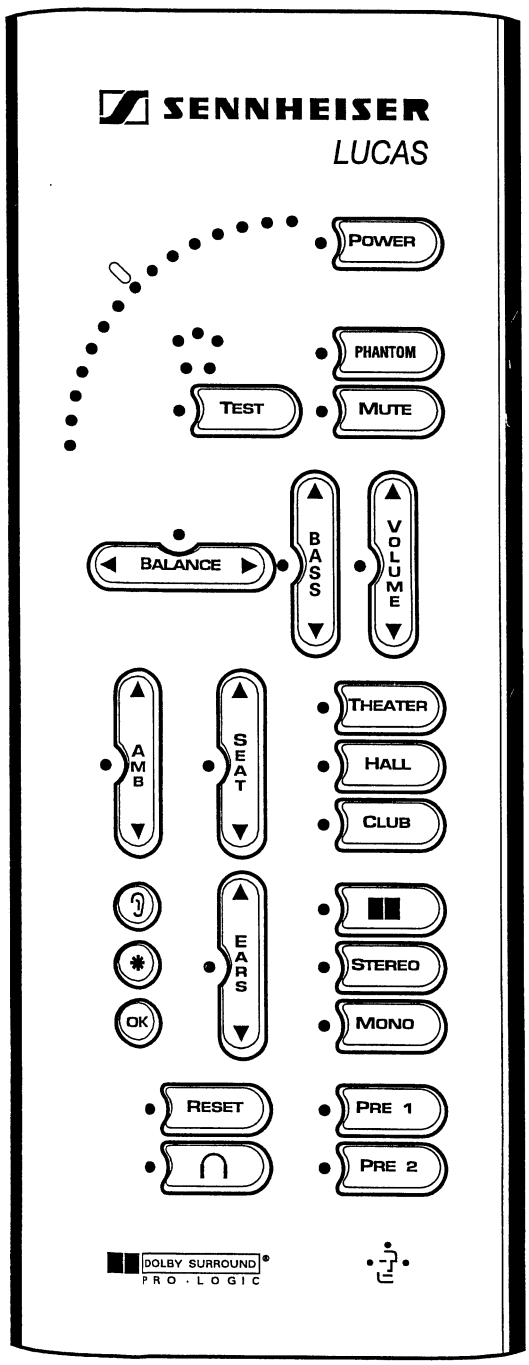
1 OPERATING CONTROLS



LED ARC
Displays the setting of the currently active parameter.

TEST
For sending a test signal (white noise) to the virtual speakers.

SEAT
For changing the position of the virtual seat in the chosen room type (THEATER, HALL, or CLUB).

AMB (AMBIENCE)
For changing the reverberation in the pre-selected room type.

EARS
Used for matching LUCAS to the user's ears. If LUCAS is not in matching mode, the EARS control serves to adjust the volume of the second headphone output (*, LR).

EAR SYMBOL
For activating the matching mode.

ASTERISK (*)
For testing the current ears setting, triggers three test signals (white noise).

OK
For selecting the current EARS setting.

RESET
Switches LUCAS back to the factory-adjusted standard settings (default mode).

HEADPHONE SYMBOL
For switching LUCAS between headphone and loudspeaker mode.

POWER
For switching LUCAS on and off and controlling LED brightness.

PHANTOM
For switching the Dolby ProLogic and Toltec processors on and off (bypass) and changing to phantom mode in loudspeaker mode.

MUTE
For muting the headphone outputs.

BASS
For adjusting the bass frequency response.

VOLUME
For controlling the output level at socket CS.

THEATER, HALL, CLUB
For choosing a virtual room type.

DOLBY, STEREO, MONO
For selecting the digital signal processing based on the source format.

PRE 1, PRE 2
Presets for saving and recalling two complete LUCAS settings.

2 TECHNICAL DATA

Frequency response (R_L > 100 kΩ)	20 - 18000 Hz (- 3 dB)
Input impedance	> 10 kΩ at 1 kHz
Input voltage	2 Vrms maximum
Total harmonic distorsion (THD at R_L > 100 kΩ)	0.01 %
Crosstalk	- 70 dB
Signal-to-noise (S/N)	85 dB
Minimum output impedance	8 Ω
Maximum output voltage	1.6 Vrms
Output power	0.24 W (8 Ω) 0.1 W (33 Ω) 0.013 W (300 Ω)
DC supply voltage ranges	8 - 12 VDC
Power comsumption	500 mA maximum at 9 VDC
Dimensions	approx. 200 x 80 x 20 mm
Weight (without cables)	approx. 700 g
Decoding type	Dolby Pro Logic®
Processing techniques	Toltec®
Outputs, headphone mode	Two 3.5 mm stereo sockets for Toltec® outputs
Outputs, loudspeaker mode (with adapters)	Four RCA outputs for Left, Right, Center, Surround
Room simulations	3 variants: Theater, Hall, Club
Preamplifier functions	Volume, Balance, and Bass Boost
Supply schedule	LUCAS, 6 m cable, mains unit

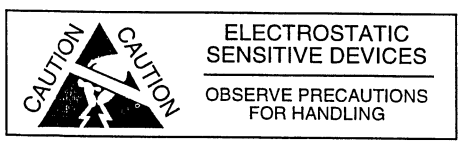
NOTES:

3 TECHNICAL DESCRIPTION

The LUCAS is a complex digital personal home theater device that produces an authentic surround sound effect over headphones. The two 3.5 mm stereo outputs are identical, except for volume control. You will note that the technical description deals with the main output only, and emphasizes the differences to the secondary outputs.

3.1 MECHANICAL DESCRIPTION

The entire circuit is built around a four layer, double-sided, 8 x 8 mil PCB with overall dimensions of 7.500" x 2.650". It is constructed of 1 oz copper with solder mask over bare copper, and an overall thickness of 0.0625". It has 29 places for conductive ink or gold flash using the top layer solder mask for placement and size. Furthermore, the majority of the parts, with the exception of the connectors and regulator, are surface mount devices (SMD). In servicing these parts, care should be taken not to damage the PCB. Electrostatic discharge (ESD) precautions should be taken at all times when handling the device.



The body is constructed of punched aluminum extrusion of overall thickness of 0.050" and complex bent metal inserts. Care should be taken not to scratch or damage the housing.

3.2 INPUT AUDIO STAGE

The input audio stage is coupled to the audio source via the provided custom cable. This cable connects to a six-pin mini-DIN located on the front of the device and the bottom side of the PCB.

3.2.1 DESCRIPTION

The input audio stage is buffered with a high performance single-supply dual operational amplifier for the left and right channels that have a gain of - 6.0 dB. This provides enough attenuation for the LUCAS to accept a 2 Vrms signal without overloading the input stage as is required by Dolby Laboratories Licensing Corporation for any Dolby Pro Logic device. Both input and output of the op amps are capacitively coupled and use 1% resistors for high precision.

3.2.2 SCHEMATIC

The analog input stage is shown in the schematic on page 17 (only the left channel is discussed.)

C50, C79, R19: High pass filter
C58, C38: Input, Output coupling capacitors
C76: Bypass capacitor
C77, R11, R20: Op amp bias voltage circuit of 2.5 V.
J6: Mini-DIN connector
R21: Feedforward resistor
R8: Feedback resistors
U17A: Operational Amplifier

3.3 A/D - DSP INTERFACE

This interface couples the now digitized input to the processor performing the software algorithms.

3.3.1 DESCRIPTION

The audio streams are sampled and provided to the DSP by the 16-bit stereo A/D converter. The interface is set by pins on the A/D converter and internal registers in the DSP that define the mode to be: A/D Master, DSP Slave, data left justified, left/right clock is left-high, and the bit clock is 64 times the sample rate. The information itself is provided to the DSP via three lines that carry the data, bit clock, and word clock.

3.3.2 SCHEMATIC

The A/D portion is in the schematic on page 16 and the DSP portion is on page 16.

C30-33, C36, C56-57, C59-60, C69, C70-72: Bypass capacitors for the A/D converter.
U6: Analog-to-Digital converter
U10: DSP

3.4 DSP-D/A INTERFACE

This interface is the reverse of the previous interface. The DSP couples the now processed digital audio streams to the D/A converter for presentation to a listener.

3.4.1 DESCRIPTION

The processed audio streams are provided to the D/A by the DSP. The interface is set by pins on the D/A converter and internal registers in the DSP that define the mode to be: DSP Master, D/A Slave, data left justified, left/right clock is left-high, and the bit clock is 32 times the sample rate. The information itself is provided to the D/A via three lines that carry the data, bit clock, and word clock.

3.4.2 SCHEMATIC

The DSP-D/A interface is shown on two pages. The DSP portion is in the schematic on page 16 and the D/A portion is on page 18.

C40-42, C61-64, C73, R16: Bypass capacitors and bias resistor.
U10: DSP
U13: Digital-to-Analog converter

3.5 OUTPUT AUDIO STAGE

The output audio stage is coupled to the listener via the provided 3.5 mm headphone jacks. These connectors are on the rear of the device and the bottom side of the PCB.

3.5.1 DESCRIPTION

The output audio stage is buffered with a high performance headphone amplifier for the left and right channels. Both input and output of the headphone amplifiers are capacitively coupled and have a gain of 10.45 dB. This provides sufficient amplification over a wide-range of headphones with impedances from 32 Ω to 300 Ω.

3.5.2 SCHEMATIC

The analog output stage is in the schematic on page 18 (only the main output is discussed.)

C14, C34: Input,Output coupling capacitors
C14, R42: High pass filter
C16, C48: Bypass capacitors.
K1, K2: 3.5 mm headphone jacks
R6: Feedforward resistor
R15: Feedback resistors
U15: Headphone Amplifier

3.6 DSP-MEMORY INTERFACE

The DSP requires an EPROM to hold the database of HRTFs and system coefficients. Furthermore, it requires a static-RAM to hold the long delays required for the audio processing as well as the surround delay for the Dolby Pro Logic algorithm.

3.6.1 DESCRIPTION

Both the EPROM and SRAM are attached to the DSP via the data, address, select, read, and write lines. The DSP maps both segments of memory linearly using the highest address and boot line (GPIO3) to select from which block of memory to read and/or write. This chip select circuit may assert only one block of memory to be accessed at any given time thus preventing bus contentions.

3.6.2 SCHEMATIC

The DSP-Memory interface is in the schematic on page 16.

C10, C24-27, C29, C49: Bypass capacitors
R2, R3: Pull-up resistors
U3C & D: 7400 Quad Nand TTL
U10: DSP
U11: EPROM
U12: SRAM

3.7 CONTROLLER-DSP INTERFACE

The controller-DSP interface is complicated due to its multi-functional goals. Not all user commands are related to DSP functions and therefore not transferred. Furthermore, the controller and DSP switch roles as master and slave depending on the functions being performed.

3.7.1 DESCRIPTION

The Controller-DSP interface occurs on three levels.

- The controller asserts the DSP reset line to coordinate all system resets.
- The controller issues commands to the DSP from the user interface. These commands are asserted on three lines to the DSP serial host port: DSP slave select, data, and clock.
- The DSP asserts a command acknowledge to the controller once a valid command has been received and processed. The acknowledgment is asserted for eight sample clocks.

3.7.2 SCHEMATIC

The Controller portion of the interface is in the schematic on page 15 and the DSP portion of the interface is shown on page 16.

C1: Bypass capacitor
U2: Microcontroller
U10: DSP

3.8 CONTROLLER-MEMORY INTERFACE

The controller is always aware of the state of the system. This state is defined as a list of parameters that is utilized in software. By recalling any set of parameters, any given system state can be constructed. This systems provides the user with the ability to store two independent sets of parameters under the label of "presets". Furthermore, a set of parameters is maintained for the stand-alone Dolby Pro Logic mode.

3.8.1 DESCRIPTION

The interface is defined by four lines between the microcontroller and memory: EEPROM select, data input, data output, and clock. This allows the microcontroller to store and recall at any given time the system state, either presets, and the loudspeaker mode.

3.8.2 SCHEMATIC

The Controller portion of the interface is in the schematic on page 15.

U1: Serial EEPROM
U2: Microcontroller

3.9 CONTROLLER-USER INTERFACE

The controller-user interface is defined by the LEDs and buttons on the front fascia of the device. Each button serves a particular well-defined function in the software design. Each command is interpreted, reformatted, and sent to the appropriate hardware component for implementation.

3.9.1 DESCRIPTION

The controller monitors all aspects of the interface and time-division multiplexes the information to the LED arrays allowing for an adjustment in LED brightness. When a button is pressed the controller acquires, interprets, and communicates those commands to the DSP (see above) or to the A/D converter for reset or to the D/A converters for control volume, mute, and balance. These commands are asserted on three lines to the D/A converter serial interface: D/A slave select, data, and clock. Furthermore, the microcontroller powers down the entire device after approximately two hours with no button activity.

3.9.2 SCHEMATIC

The Controller portion of the interface is in the schematic on page 15 and the button/LED portion of the interface is shown on page 19.

C53: Bypass capacitor
D3-7: General purpose diodes
D8-47: Display LEDs
R17, R41: Pull-up resistor.
R25-40: Current limiting resistors for LEDs
U2: Microcontroller
U7: 74174 Hex D type Flip-Flop
U26: 74245 Octal Bi-directional bus transceiver with three-state outputs
U27: 74574 Octal D type Flip-Flop

3.10 CLOCKING AND POWER SYSTEMS

The clocking and power systems are distributed to all other components as needed. Furthermore all system clocks are derived from the same original master clock. Independent power systems exist for digital and analog circuits. This separation of power systems provides improved analog performance.

3.10.1 DESCRIPTION

All system clocking information is derived on-board from a 20 MHz circuit. Additional clock frequencies and system uses are derived as follows:

- 20 MHz clock via a parallel resonance circuit: DSP, D/A converter
- 10 MHz clock via a divide by two circuit using a D type flip-flop: A/D converter
- 4 MHz clock via a decade counter: Microcontroller

All power systems are derived from the power input on the mini-DIN connector. The separate power circuits are as follows:

- Digital Power system via a standard 3 pin regulator.
- Analog Power system via a low voltage drop out IC regulator.

3.10.2 SCHEMATIC

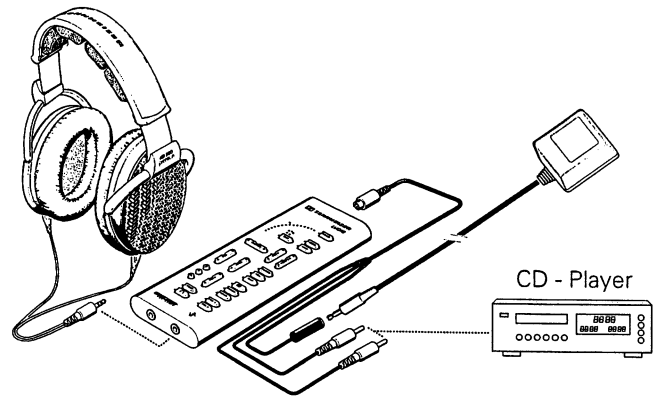
The Clocking and Power systems are in the schematic on page 15.

C2-9, C19, C22-23, C28, C37: Bypass capacitors
C17, C18, R1, X1: Parallel resonance circuit
D1: Voltage regulator circuit
J6: Mini-DIN connector
U3A & B: 74HC00 Dual input nand gates.
U4A: 74HC74 Dual D type flip-flop
U5: 74LS90 Decade counter
U8: Low Voltage Dropout regulator
U9: Standard Voltage Regulator

NOTES:

4 GENERAL TESTING

- Compact Disc player
- HD 580 Headphone
- Test Disc



In order to narrow down the possible causes of a fault, you should first perform a general test on LUCAS, including

- a check of all operating controls and functions
- a check of the acoustic properties using a test CD.

4.1 SIGNAL FLOW, CONNECTIONS

Connect LUCAS as shown in the above test set-up.

- Connect LUCAS to the mains (via plug-in mains unit) and to a CD player (with the CD player providing a stereo audio signal).
- Connect a pair of headphones to socket "CS".
- Press POWER.
  All LEDs should briefly light up. Then the only LEDs lit should be POWER, PHANTOM, VOLUME, THEATER, the LEDs beside the Dolby and the headphone symbol and the bottom LED of the LED arc.
- Press PHANTOM.
  The music signal should be free of distortions and present at both earpieces.
- Disconnect the left audio cable on the CD player, then plug it in again and disconnect the right audio cable.
  There should be no audio signal in the disconnected channel of the headphone.
- Shake and move the connection cable on LUCAS.
  The music signal should not be disturbed (loose contacts!). LUCAS should remain switched on (power supply!).

NOTES:

4.2 CHECKING THE OPERATING CONTROLS

POWER

- Press the POWER button momentarily.
  All LEDs should briefly light up, then the only LEDs lit should be POWER, PHANTOM, VOLUME, THEATER, the LEDs beside the Dolby and the headphone symbol and the bottom LED of the LED arc. LUCAS is now switched on.

- Press and hold down POWER for about 3 seconds.
  The POWER LED should blink several times and then go off. LUCAS is now switched off.

- Press and hold down POWER for some time.
  All LEDs should be lit when the button is held down.
  All LEDs should have the same brightness.
  LUCAS is now switched on, the only LEDs lit should be POWER, PHANTOM, VOLUME, THEATER, the LEDs beside the Dolby and the headphone symbol and the bottom LED of the LED arc.

Brightness control

- With LUCAS switched on, press POWER momentarily.
  The LEDs should become darker (brightness level: medium)
- Press POWER again.
  The LEDS should become darker once more (brightness level: dim).
- Press POWER a third time.
  LUCAS will return to its initial brightness level (bright).

VOLUME

VOLUME controls the ouput level of the right headphone output ("CS"). The current setting is indicated by the LED arc. The VOLUME LED should be lit.
When changing the volume setting, the corresponding LEDs of the LED arc should light up.

PHANTOM

- Press PHANTOM to switch off the Toltec and Dolby processors. LUCAS will reproduce the "normal" music signal.
  The PHANTOM LED should go off.
  The sound should change.
  The only LEDs lit should be POWER, VOLUME, and one LED of the LED arc.
  The only operational controls should be POWER, VOLUME, EARS, MUTE, RESET, PRE1, and PRE2.
- Press PHANTOM again.
  LUCAS should return into Dolby mode, all previous functions should be restored.

MUTE

- Press MUTE to mute both headphone outputs.
  The MUTE LED should light up.
  The audio signal should be switched off.
  All other controls and buttons (except POWER) should be without function.
- Press MUTE again.
  All functions should be restored.

TEST

With TEST, you can send a test signal (white noise) to each of the virtual speakers and thus check their "position".

- Press TEST. Each touch of the TEST button tests a different speaker in the following order: front left, centre, front right, rear right, rear left.
  The TEST LED should light up.
  The LEDs of the LED circle (indicating the virtual speakers) should light up one after the other, beginning with the top left LED.
  The virtual speaker (direction of sound) should correspond to the LED lit.
  The BALANCE, MUTE, SEAT, VOLUME, and EARS (VOLUME 2) controls should be operational.

When TEST is pressed for the 6th time, the LEDs should go off, and there should be no test signal.

BALANCE, BASS, VOLUME, AMB(IENCE), SEAT, EARS

The values for BALANCE, BASS, VOLUME, AMB(IENCE), SEAT, and EARS can be increased or decreased, which is indicated by the arrows on the respective controls. The setting of the currently active parameter is indicated by the LED arc.

- If the controls are pressed for the first time, the LED arc should indicate the factory-adjusted standard setting:
  Position 8 (8th LED lit) for the BALANCE, BASS, AMB, and SEAT controls;
  Position 1 (bottom LED lit) for the VOLUME and EARS (VOLUME 2) controls.
  The LED lit on the arc should change depending on the alteration of the value.
  The LED of the currently operated control should be lit.
- If you press EARS, the LED of the EARS (VOLUME 2) control should blink.

In the following, the function of the controls is described briefly, check whether they work correctly:

- BALANCE: For controlling the stereo balance.
- BASS: For adjusting the bass frequency response.
- VOLUME: For controlling the output level of socket CS.
- AMB: For changing the reverberation. It is easiest to test the reverberation when you switch off the audio signal at the CD player and listen.
- SEAT: For changing the position of the virtual seat in a chosen room type.
- EARS: For adjusting the volume of the second headphone output (LR) when LUCAS is not in matching mode.

THEATER, HALL, CLUB

- These buttons serve to select a virtual room type.
  Only the LED of the chosen venue should be lit.
  The sound should change (reverberation, reflections, etc.) when you choose a different room type.

DOLBY, STEREO, MONO

These buttons match the digital signal processing method to the audio source format.

Only the LED beside the chosen processing type should be lit.

PRE1, PRE2

These presets serve to store and recall two complete settings.

- To store the settings for a headphone, press PRE1 for about 2-3 seconds.
  The LED of the preset button should blink four times, then all LEDs should light up briefly to indicate that the settings have been stored.
  The chosen settings should have been stored.
- For recalling, press PRE1 and make sure that the LED beside the button blinks at least once. (N.B.: Do not hold down the button for too long as this would store the current settings

rather than recall PRE 1.)
The stored settings should have been recalled.
- Choose different settings and store them with PRE2, then check as with PRE1.

RESET

RESET switches LUCAS back to the factory-adjusted standard settings.

- Press and hold down RESET.
The RESET LED should blink four times, then all LEDs should light up briefly to indicate that LUCAS has returned to default mode.
LUCAS should have returned to the standard settings.

HEADPHONE SYMBOL

The button with the headphone symbol serves to switch LUCAS between headphone and loudspeaker mode. In loudspeaker mode, the "LR" and "CS" outputs drive an amplifier with loudspeakers. LUCAS delivers the left, right, centre and surround signals to the speakers.

- Press and hold down the button with the headphone symbol.
The LED beside the headphone button should light up four times and then go off.
The only lit LEDs should be POWER, DOLBY, VOLUME and one LED of the LED arc.
The only operational controls should be POWER, PHANTOM, MUTE, TEST, and VOLUME.
- Press TEST.
The LED beside the TEST button and the top left LED of the LED circle should light up.
- Press TEST again.
The next LED of the LED circle should light up, and so on, indicating the position of the corresponding speakers: front left, centre, front right, surround (here, the LEDs for both rear speakers should be lit).

When you connect a headphone to the "LR" socket, you should hear a hissing noise coming from the front left and front right. When you connect the headphone to the "CS" socket, the left headphone capsule should produce a hissing signal coming from the centre, the right capsule should reproduce the surround (rear) channels. The bottom LEDs of the LED circle should be lit.
Please note that the volume of the test signal corresponds to the setting chosen before TEST was presssed.
- Press TEST a fifth time.
All LEDs should briefly light up. The test function should be switched off.
- Press and hold down the button with the headphone symbol.
The LED beside the button should blink four times and then remain lit. LUCAS should have returned into headphone mode and to the factory-adjusted standard settings.

NOTES:

EAR SYMBOL

The round button with the ear symbol is used to switch LUCAS to matching mode, where one of fifteen possible Head-Related Transfer Functions (HRTF) can be chosen.

- Press the button with the ear symbol.
The VOLUME LED should go off, and the EARS LED should light up permanently.
- Press the EARS (VOLUME 2) control to select a different ear type.
The next or previous LED of the LED arc should light up, depending on whether you pressed "up" or "down".
- If you press EARS momentarily you only choose a new ear type, by pressing it for about 2 - 3 seconds you select a different HRTF and trigger a test signal (three hissing noises at socket CS). The test signal can also be produced by pressing the button with the asterisk (*).
- To select the current ear type, press OK.
The EARS LED should go off and the VOLUME LED should light up. LUCAS should now operate with the selected HRTF.

NOTES:

5 SERVICE HINTS

5.1 DISASSEMBLY

To disassemble the device, perform the following steps and refer to the exploded diagram.

- Unplug all connectors!
- Peal away the two oval feet (6)
- Remove the four screws (7) located beneath the oval feet.
- Remove the internal end cap (10) from the LUCAS enclosure (8).
- Remove the internal cartridge (2) from the LUCAS enclosure.
- Remove the keypad and PCB from the LUCAS enclosure. Take care not to damage the buttons on the keypad (11) during its removal.
- Separate the keypad from the PCB by gently pulling on one corner. For many of the troubleshooting tests, leaving the keypad in place facilitates the routine.

6 GENERAL SERVICING

6.1 SPECIAL TOOLS AND EQUIPMENT

- Multimeter (MM)
- Oscilloscope, 2 channel (OS1, OS2)
- Waveform generator, 2 channel with inverters (WG1, WG2)

6.2 TEST SETUP

- Connect the LUCAS cable to the mini-DIN located on the front of the board.
- Connect the left (white) and red (right) RCA plugs to the two channels of the waveform generator.
- Connect the power adapter to the DC socket on the LUCAS cable.
- Connect the two 3.5 mm plug to RCA socket Y-adapters to the LUCAS outputs.
- Connect the appropriate output to the oscilloscope or multimeter.

7 TROUBLESHOOT INSTRUCTIONS

These tests perform a series of diagnostics to check the performance of different areas and/or specific components of the device in question. With the following instructions, it is possible to test the device and draw conclusions from the observed circuits. These observations will allow the technician to address and identify the problem.

Testing mode describes the functional or listening mode in which the device should be placed during the test. *Procedure* outlines where the technician would examine the circuit to see if it is functioning correctly. *Analysis* directs the service technician toward the problem.

7.1 POWER SYSTEMS

Testing mode: Bypass

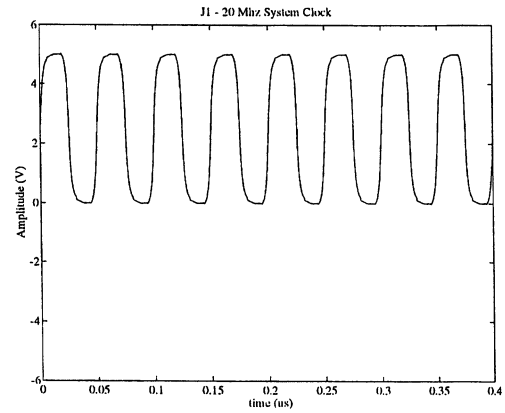
Procedure: Probe J2 for 5.0 ± 0.1 V -Digital power system (MM).
Probe J3 for 5.0 ± 0.1 V -Analog power system (MM).

Analysis: Check for shorts to ground, Schottky diode, and regulators (MM).

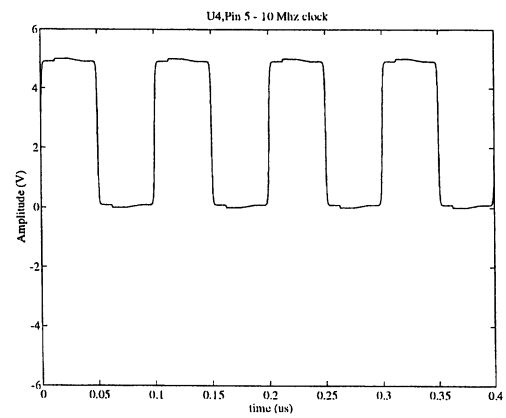
7.2 CLOCKING SYSTEMS

Testing mode: Bypass

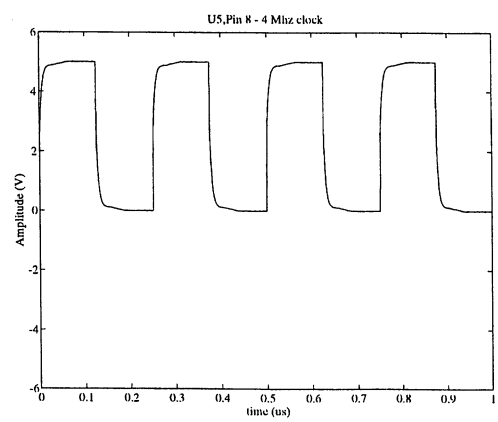
Procedure: Probe J1 for 20 MHz, 5.0 V Clocking signal. This is the system clock from which all other clocks are derived (OS1).



Probe U4, pin 5 for 10 MHz, 5.0 V clocking signal -A/D clock (OS1).



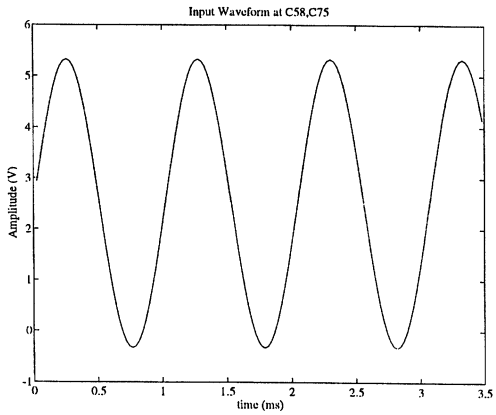
Probe U5, pin 8 for 4 MHz, 5.0 V clocking signal -Microcontroller clock (OS1).



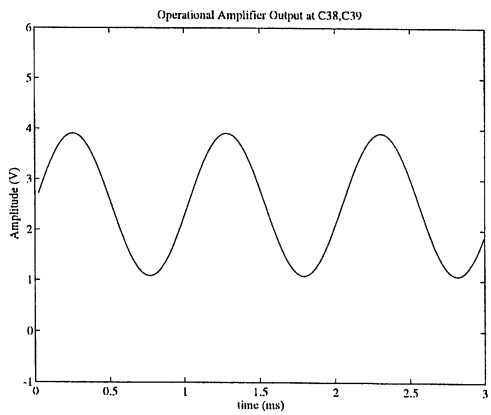
Analysis: Check X1 - crystal oscillator (OS1).

7.3 INPUT AUDIO STAGE

Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2).
Procedure: Probe C58, C75 for the input waveforms (OS1).



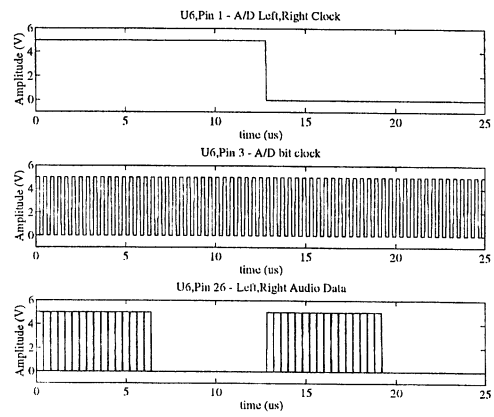
Probe C38, C39 for 1kHz, 1 Vrms outputs (OS1).



Analysis: Check U17, pin 4,8 for analog power and ground (MM).
Check U17, pin 3,5 for a bias voltages of 2.5 V (MM).
Check all coupling and bypass capacitors (OS1).

7.4 ANALOG-TO-DIGITAL STAGE

Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2).
Procedure: Probe U6, pin 1 (trigger this output) for a 25.6 ms word clocking signal (OS1).
Probe U6, pin 3 for a 0.40 ms bit clocking signal (OS2).
Probe U6, pin 26 for 16-bit data (OS2).



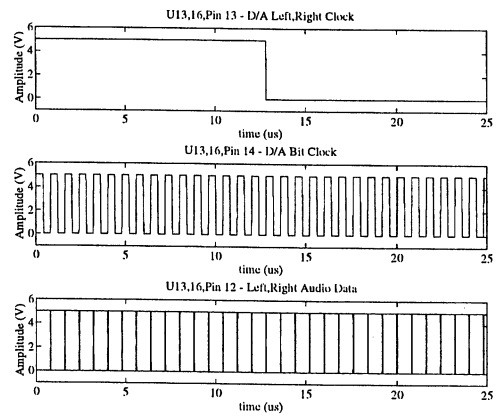
Analysis: Check 10 MHz clock on U6, pin 28.
Check U6 for analog and digital power and ground (MM).
Check all coupling and bypass capacitors around U6 (OS1).

7.5 DSP

The DSP is a complicated IC and two tests should be performed. The first test determines if the DSP is passing information correctly. The second test determines if the device is processing commands properly.

7.5.1 DSP-AUDIO PASS THROUGH

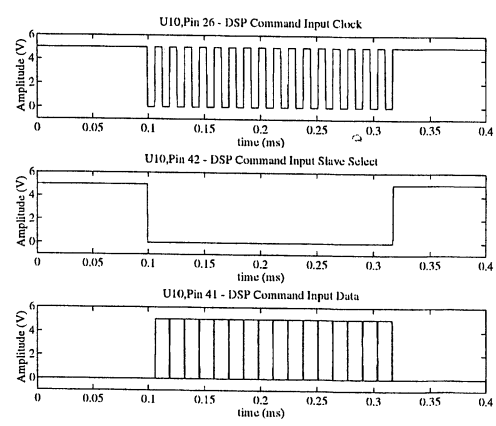
Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2)
Procedure: Probe J5 for the boot signal to be asserted low after power-on (OS1).
Probe U13,U16, pin 13 (trigger this output) for a 25.6 ms word clocking signal (OS1).
Probe U13,U16, pin 14 for a 0.80 ms bit clocking signal (OS2).
Probe U13,U16, pin 12 for 16-bit data (OS2).



Analysis: Check 20 MHz clock on U10, pin 27 (OS1).
Check continuity on all address and data lines from U10 to U11 (MM).
Check U10 for digital power and ground (MM).
Check all coupling and bypass capacitors around U10 (OS1).

7.5.2 DSP-COMMAND PROCESSING

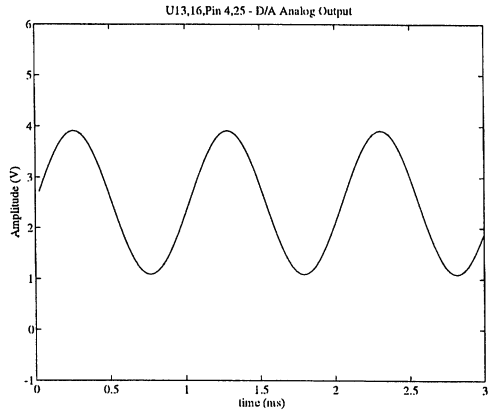
Testing mode: Phantom headphone: 1 Vrms sine wave (WG1, WG2).
Procedure: Probe U2, pin 14 while pressing the "TEST" button. The line should temporarily be asserted low (OS1).


U10,Pin 26 - DSP Command Input Clock
U10,Pin 42 - DSP Command Input Slave Select
U10,Pin 41 - DSP Command Input Data
Amplitude (V)
time (ms)

Analysis: Check 20 MHz clock on U10, pin 27 (OS1).
Check coupling capacitors around U10 (OS1).
Check U10, pin 26, 41, and 42 for command inputs (OS1).

7.6 DIGITAL-TO-ANALOG STAGE

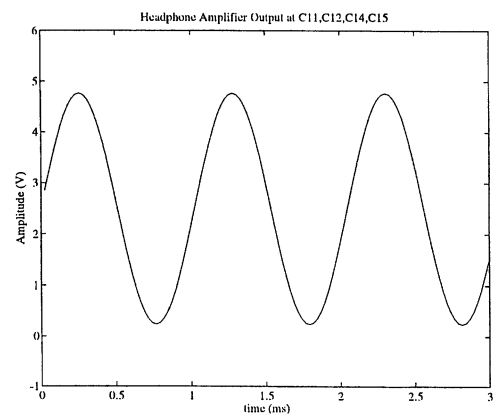
Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2), Volumes at maximum.
Procedure: Probe U13 & U16, pin 4 & 25 for a 1 kHz ,1 Vrms sine wave (OS1).



Analysis: Check 20 MHz clock on U13 & U16, pin 16.
Check coupling and bypass capacitors around U13 & U16 (OS1).

7.7 OUTPUT AUDIO STAGE

Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2), Volume at maximum.
Procedure: Probe C20, C21 & C34, C35 for a 1 kHz,1 Vrms sine wave (OS1).
Analysis: Check mute and/or volume settings.
Check coupling and bypass capacitors around U14 & U15 (OS1).
Testing mode: Bypass: 1kHz, 2 Vrms sine wave (WG1, WG2), Volume at 3rd LED to maximum.
Procedure: Probe C11, C12 & C14, C15 for a 1 kHz,1.6 Vrms sin wave (OS1).



Analysis: Check mute and/or volume settings and coupling capacitors around U13 & U16.

7.8 MEMORY SYSTEM

This system uses three different memory types, consequently there are three tests to perform. The first test deals with the SRAM for audio delays. The second test deals with the EPROM for program information and database. The third test deas with the EEPROM for user preset storage.

7.8.1 SRAM

Testing mode: Phantom headphone: Grounded input (WG1, WG2).
Procedure: Check data, address, select, read, & write lines for continuity from U10 to U12 (MM).
Watch for read/write lines to be asserted low on U12 (OS1).
Analysis: Listening test - no popping or cracking.

7.8.2 EPROM

Testing mode: HRTF matching selecting different HRTF sets.
Procedure: Check data, address, select, & read lines for continuity from U10 to U11 (MM).
Watch for read (no write) lines to be asserted low on U11 (OS1).
Analysis: Listening test - no popping or cracking.

7.8.3 EEPROM

Testing mode: Phantom headphone: 1 Vrms sine wave (WG1, WG2) using Pre1, Pre2.
Procedure: Check data, address, select, & read lines for continuity from U1 to U2 (MM).
Watch for read line to be asserted low on U1 (OS1).
Analysis: Examine LEDs after storing and recalling information. Perform listening tests.

7.9 CONTROLLER SYSTEM

Testing mode: Phantom headphone: 1 Vrms sine wave (WG1, WG2).
Procedure: "RESET" the device and check for the reset lines to be asserted low on the A/D, DSP, and D/A (OS1).
Using the "VOLUME" buttons and check for select lines to be asserted low on the primary D/A, & secondary D/A (OS1).
Cycle the "TEST" button and check the select and tagbit acknowledge lines to be asserted on the DSP (OS1).
Probe LED array select and button read lines (OS1).
Analysis: Check clocks, pull-up resistors, and bypass capacitors (OS1).

7.10 USER INTERFACE SYSTEM

Testing mode: Phantom headphone: 1 Vrms sine wave (WG1, WG2).
Procedure: Press each button and examine the corresponding LEDs.
Analysis: Test suspect diodes (MM).

7.11 LUCAS SPECIFICATIONS VERIFICATION

This set of tests are provided to determine the device's performance in comparison to the LUCAS specifications. Futhermore all stand-alone Dolby Pro Logic tests are performed with the following encoded Pro Logic inputs with a given voltage Vin:

Left	V_{in} Left input; 0 Vrms Right input (WG1, WG2).
Right	0 Vrms Left input; Vin Right input (WG1, WG2).
Center	V_{in} - 3 dB for each Left and Right inputs (WG1, WG2).
Surround	V_{in} -3 dB for Left input; (Vin - 3 dB) for Right input (WG1, WG2).

Testing mode describes the functional or listening mode in which the device should be placed during the test. *Procedure* outlines the tests that the technician should perform. *Analysis* describes the testing goal. Criterion outlines the required performance specifications.

7.11.1 GAIN/FREQUENCY RESPONSE

Testing mode: Bypass
Procedure: Left/Right inputs receive a 1 Vrms tone at the following frequencies:
25, 50, 100, 200, 500, 1000, 3000, 5000, 10000, and 15000 Hz
Analysis: Tone levels are analyzed for overall gain and relative flatness across all frequencies and output channels.
Criterion: (1) Gain: - 1.5 dB ± 1 dB at 1000 Hz,
(2) Frequency Response: ± 1.5 dB relative to 1000 Hz.

7.11.2 NOISE FLOOR (FLAT, CCİR WEIGHTED)

Testing mode: Bypass
Procedure: Left/Right inputs receive a 2 Vrms tone at the following frequencies:
1000, 3000 Hz.
Analysis: Signal-to-Noise measurements are taken for all four outputs for each weighting noted above.
Criterion: (1) Flat weighted: > 80 dB,
(2) CCIR weighted: > 85 dB

7.11.3 TOTAL HARMONIC DISTORTION (THD)

Testing mode: Bypass
Procedure: Left/Right inputs receive a 1 Vrms, 1000 Hz tone.
Analysis: Standard THD analysis using the first five harmonics at each channel output.
Criterion: < 0.02 %

7.11.4 DOLBY CARDINAL POINT SEPARATION

Testing mode: Stand-alone Dolby Pro Logic Decoder
Procedure: Encoded Dolby level inputs (350 Vrms, 3000 Hz tone for Left/Right, 250 mVrms, 3000 Hz tone for Center/Surround) presented to the Pro Logic Decoder.
Analysis: All four decoded outputs are measured relative to one another for any encoded channel.
Criterion: <-25 dB between channels, per Dolby Licensing Manual Vol. 5.

7.11.5 SURROUND CHANNEL B-TYPE FILTER

Testing mode: Stand-alone Dolby Pro Logic Decoder
Procedure: Encoded Dolby Surround input (250 mVrms, 3000 Hz) presented to the Pro Logic Decoder, then reduced by 25 dB.
Analysis: Decoded surround output is analyzed at each level. The B-Type filter action is interpreted.
Criterion: -5 dB ± 1.5 dB b-type action, per Dolby Licensing Manual Vol. 5.

7.11.6 SURROUND CHANNEL FREQUENCY RESPONSE

Testing mode: Stand-alone Dolby Pro Logic Decoder
Procedure: Encoded Dolby Surround input (1 Vrms white noise) presented to the Pro Logic Decoder.
Analysis: A standard FFT analysis is performed on the decoded surround output.
The FFT analysis examines the following frequencies: 996, 4980, 6992, and 13984 Hz. The roll-off is to ensure that the 7 kHz filter is active in the surround channel.
Criterion: < - 6.0 dB rolloff

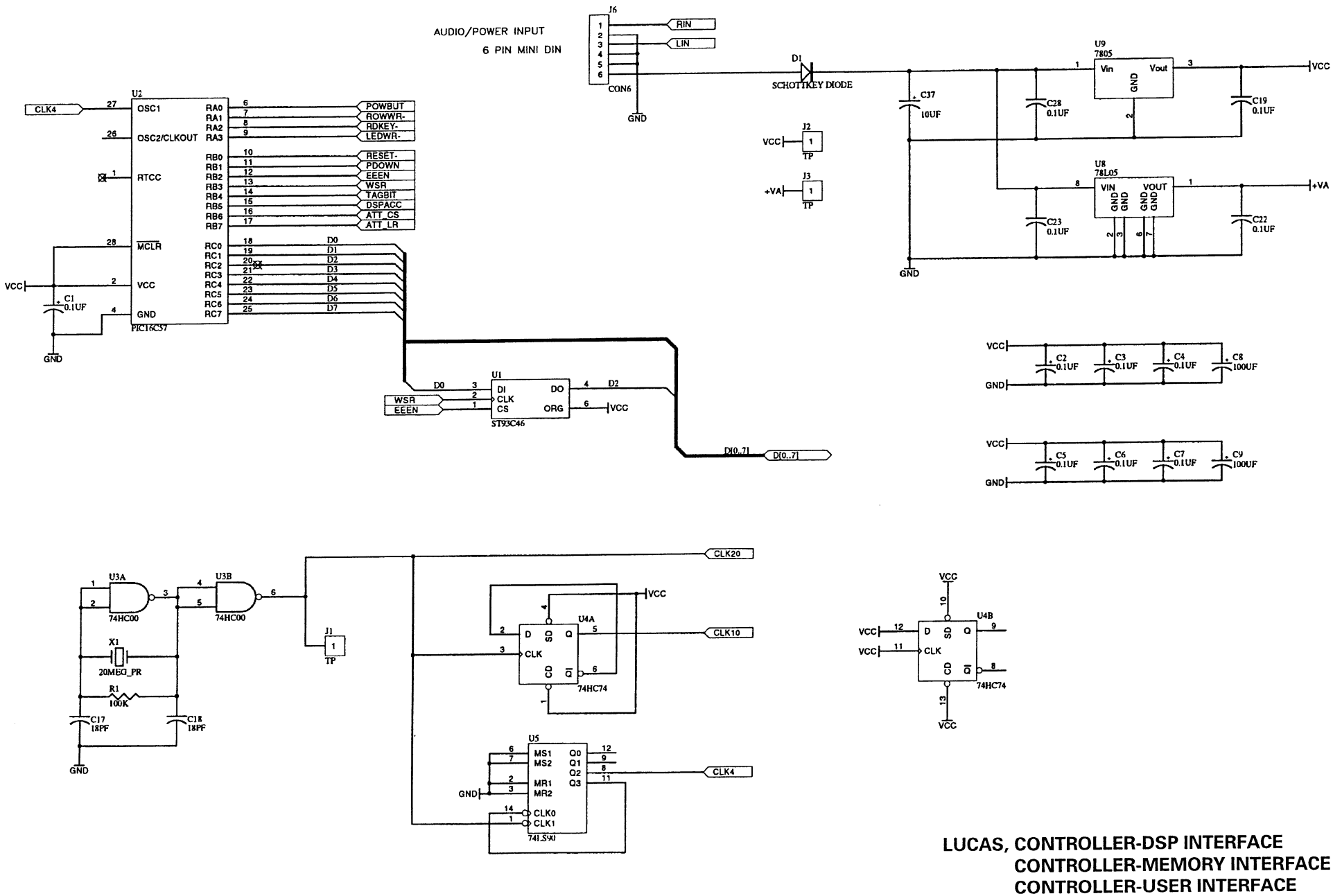
7.11.7 HEADROOM

Testing mode: Stand-alone Dolby Pro Logic Decoder
Procedure: Encoded Dolby level inputs (350 mVrms, 3000 Hz tone for Left/Right, 250 mVrms, 3000 Hz tone for Center/Surround) presented to the Pro Logic Decoder are increased by 15 dB.
Analysis: Standard THD analysis using the first five harmonics at each channel output.
Criterion: < 3.0 % THD, per Dolby Licensing Manual Vol.5.

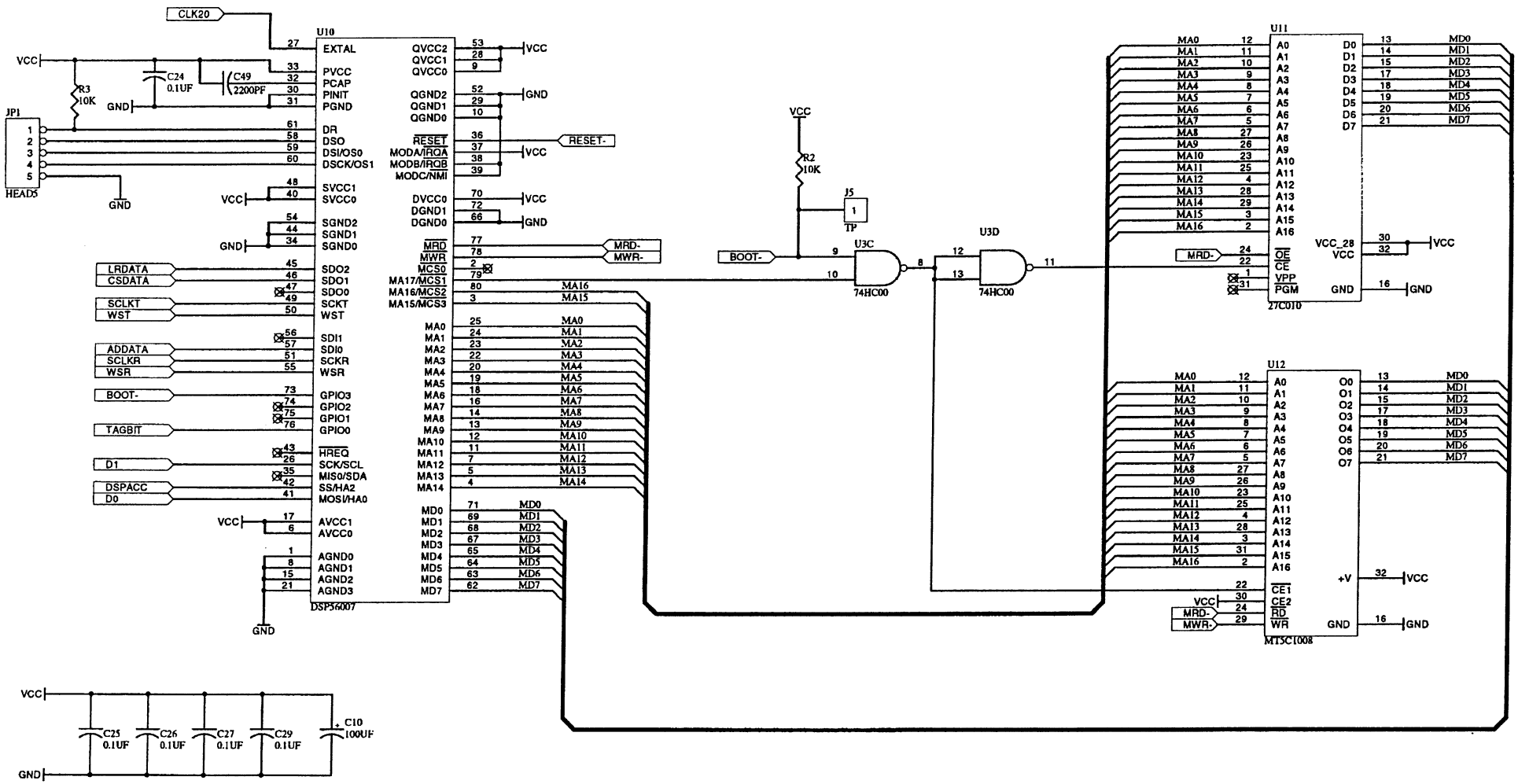
7.11.8 NOISE SEQUENCER LEVEL TRIMS

Testing mode: Stand-alone Dolby Pro Logic Decoder
Procedure: Present pink noise for speaker matching at each channel output using "TEST" button.
Analysis: Each channel is analyzed for equal levels at the nominal setting.
Criterion: ± 1 dB difference between channels, per Dolby Licensing Manual Vol. 5.

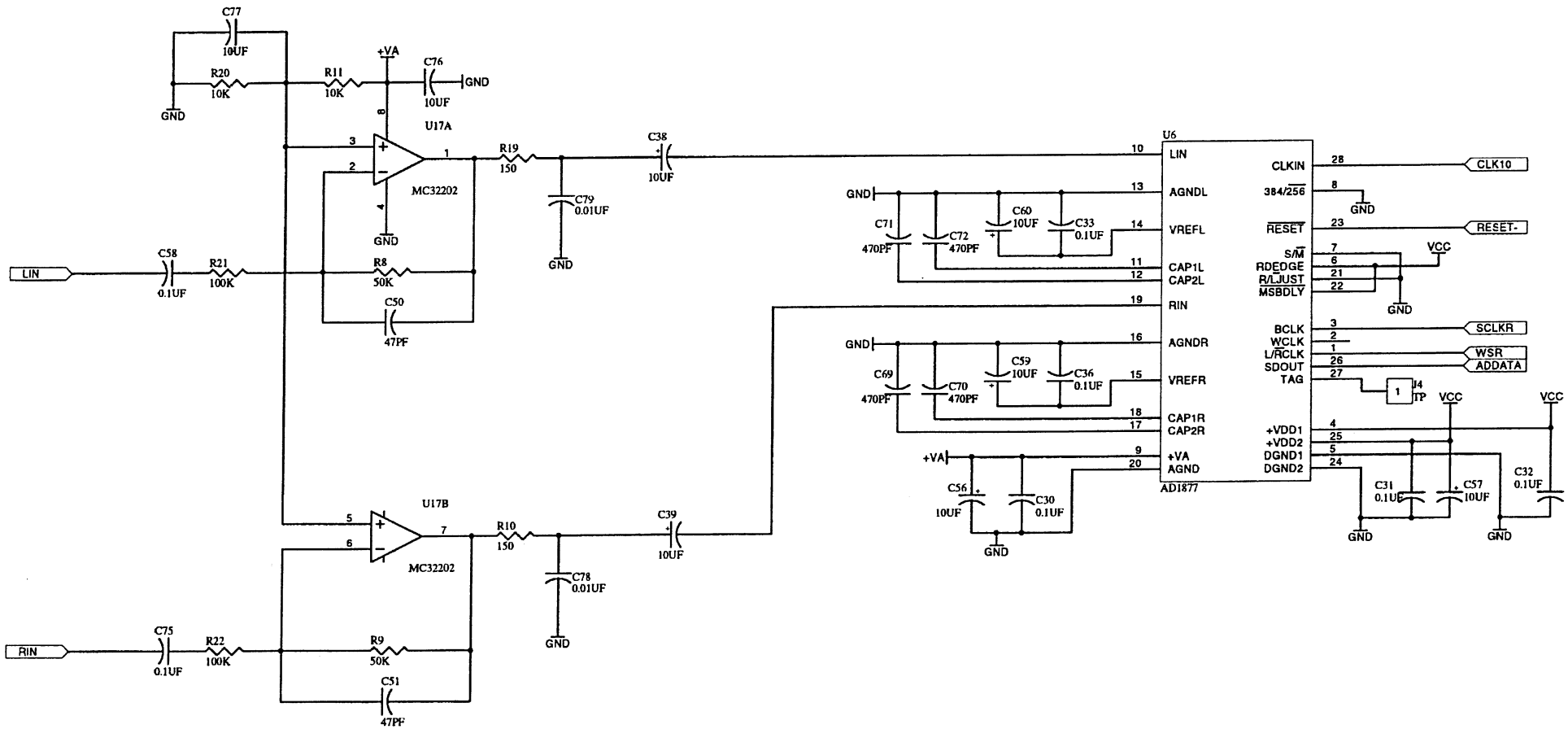
NOTES:



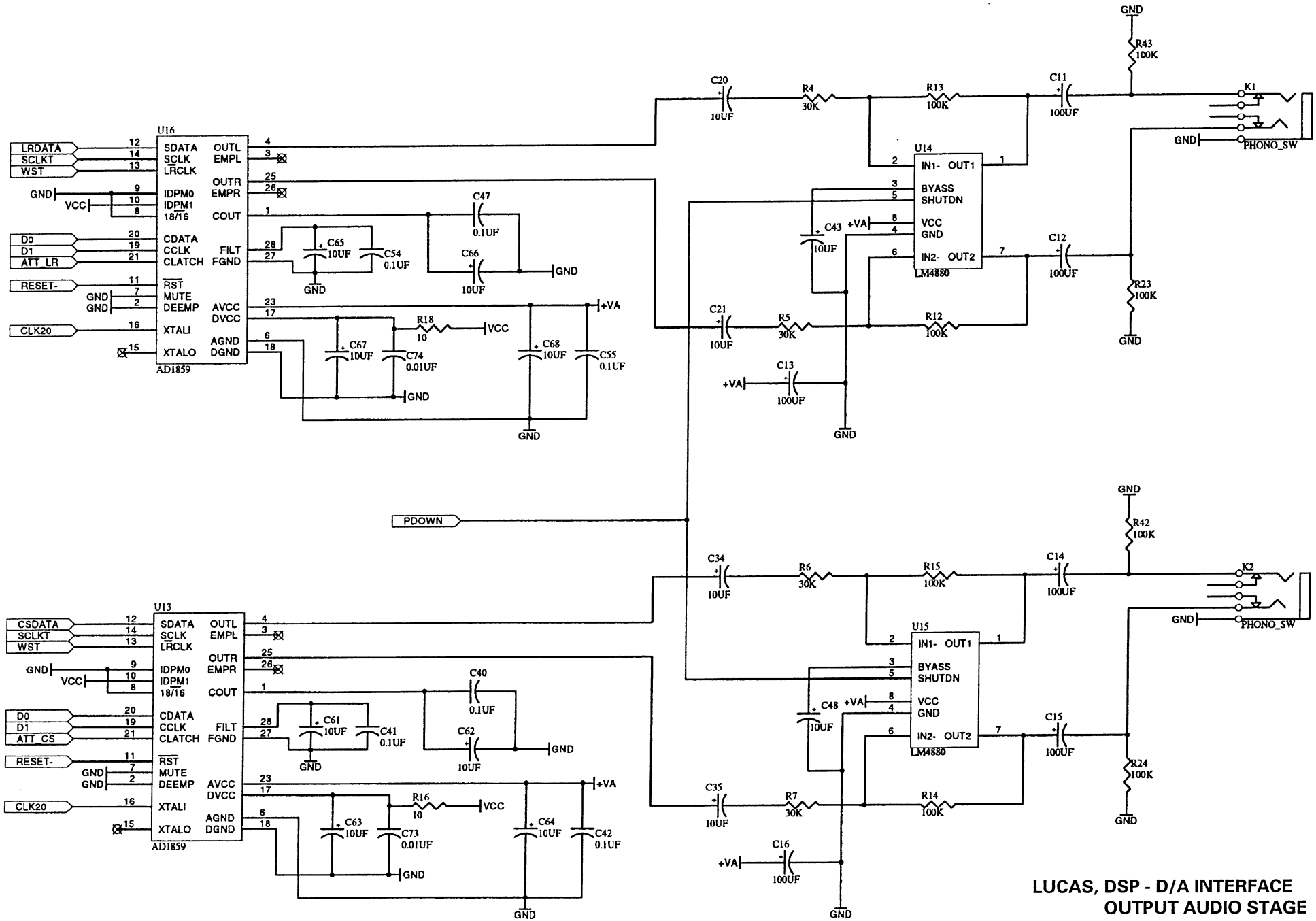
LUCAS, CONTROLLER-DSP INTERFACE
CONTROLLER-MEMORY INTERFACE
CONTROLLER-USER INTERFACE
CLOCKING AND POWER SYSTEMS



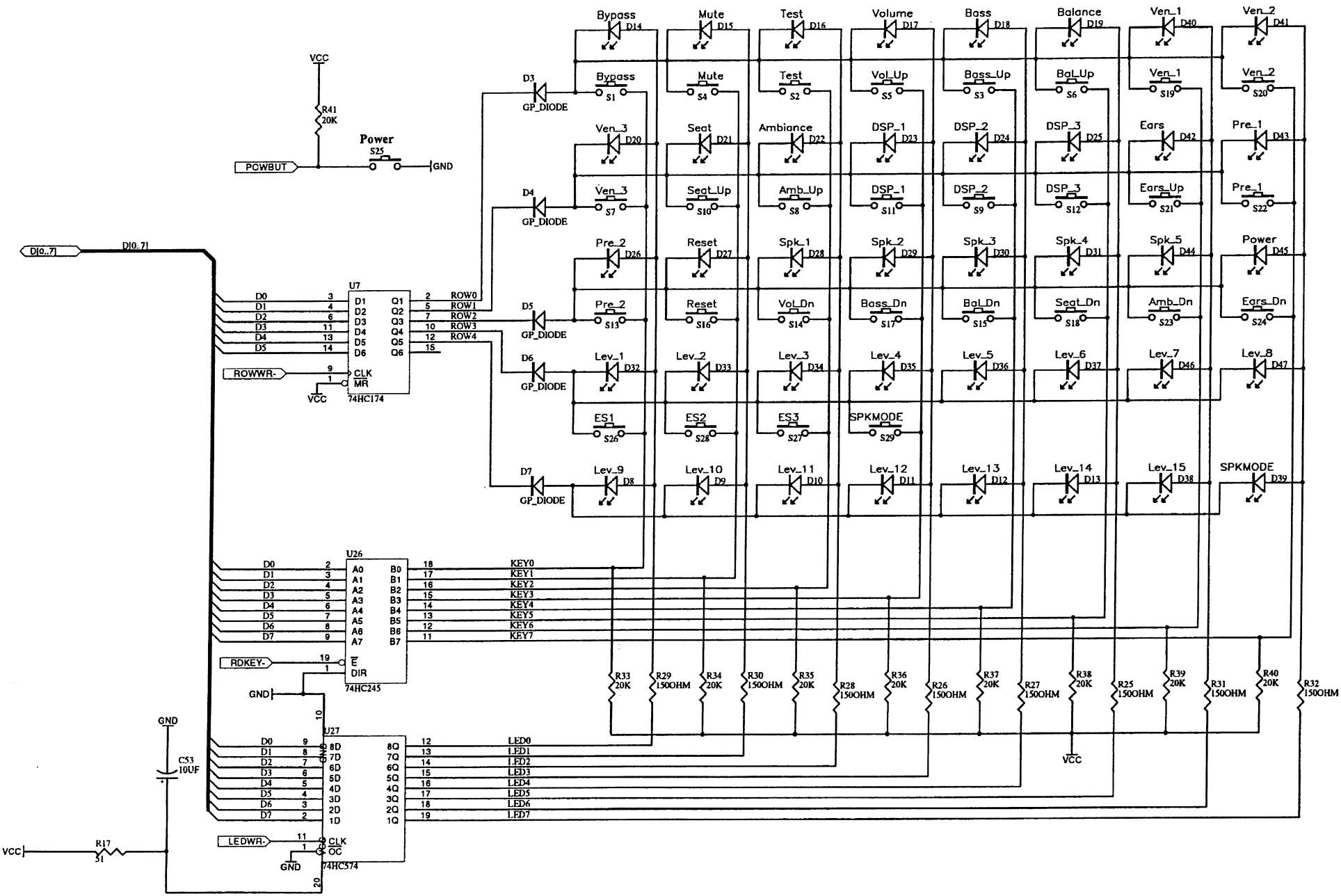
LUCAS, A/D - DSP INTERFACE
DSP - D/A INTERFACE
DSP-MEMORY INTERFACE



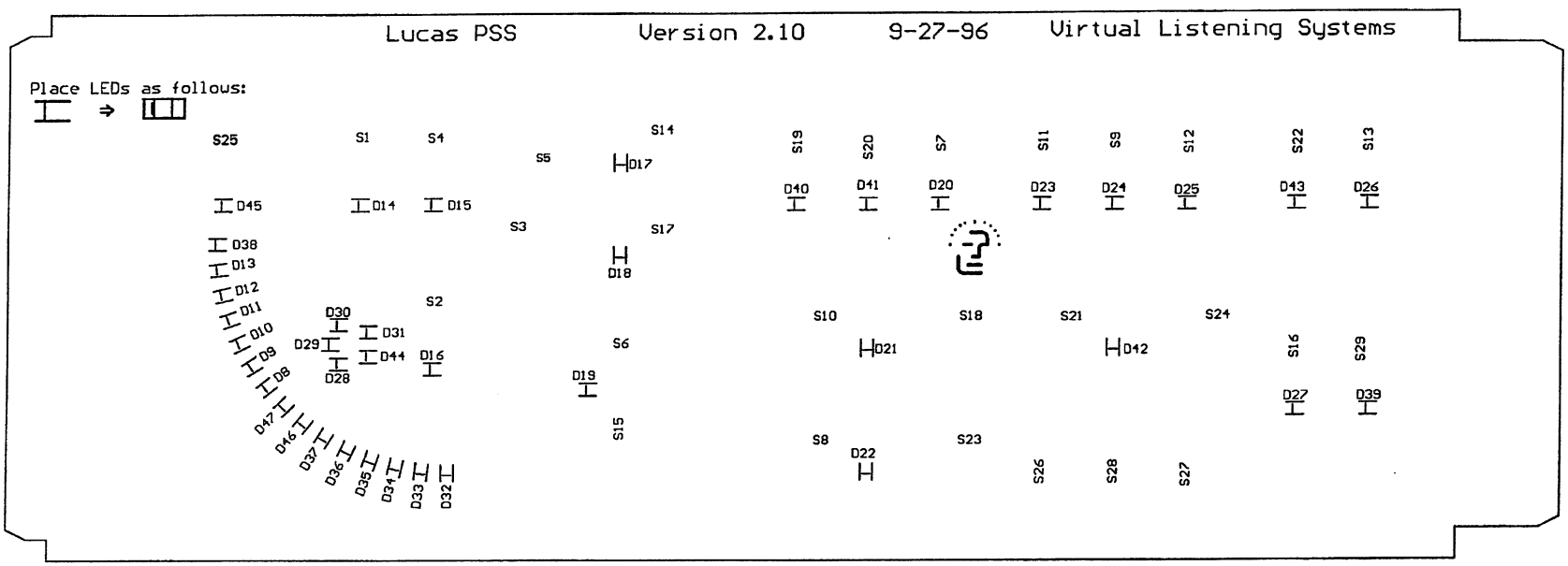
LUCAS, AUDIO INPUT STAGE
A/D - DSP INTERFACE



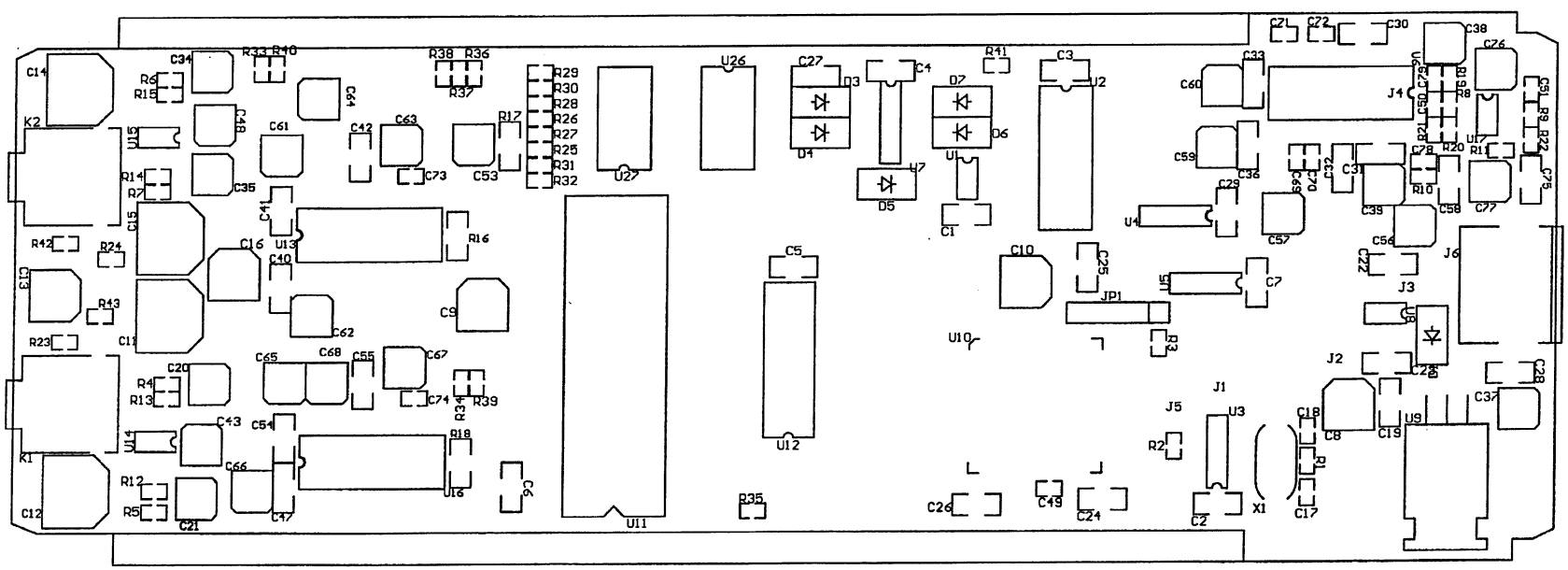
LUCAS, DSP - D/A INTERFACE
OUTPUT AUDIO STAGE



LUCAS, CONTROLLER-USER INTERFACE

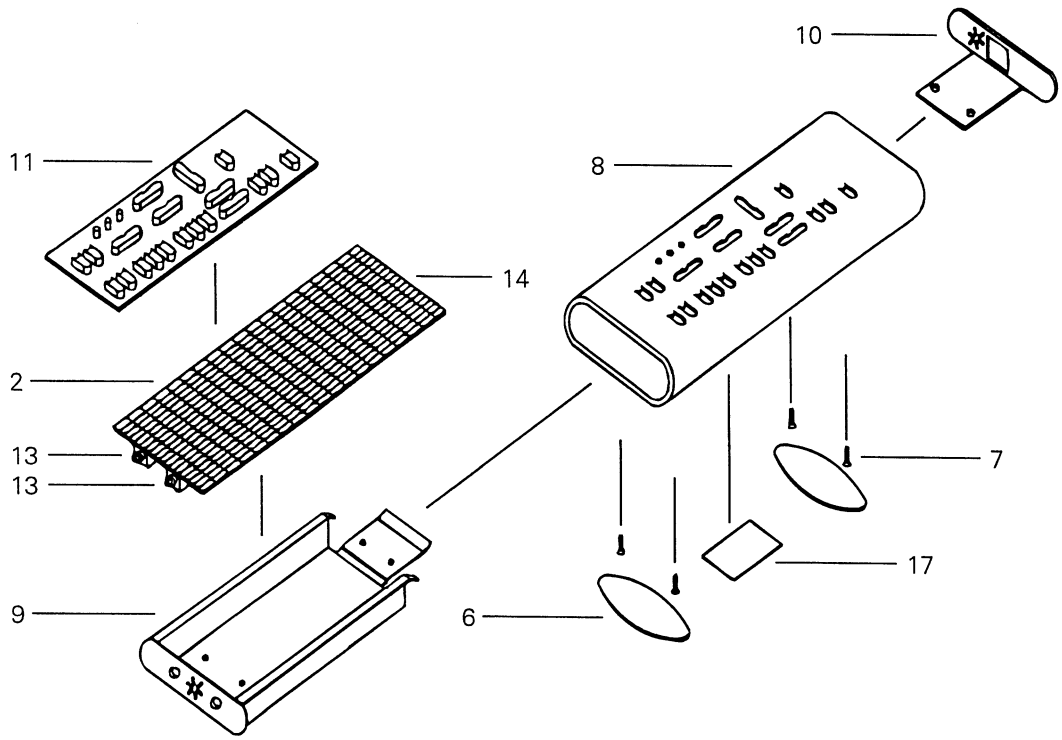


LUCAS, TOP SILKSCREEN LAYER



LUCAS, BOTTOM SILKSCREEN LAYER

9 EXPLODED VIEW



10 ERSATZTEILE

10 SPARE PARTS

POS	IDENT	BEZEICHNUNG	DESCRIPTION
001	59878	Anschlusskabel, 6m	Connecting cable, 6m
002	70615	Leiterplatte, bestückt (Austausch!)	Printed circuit board, assembly (exchange!)
003	70616	Stecker-Netzteil EU 230V	AC/DC converter EU 230V
004	70617	Stecker-Netzteil UK 240V	AC/DC converter UK 240V
005	70618	Stecker-Netzteil US 120V	AC/DC converter US 120V
006	70620	Fuss	Foot, rubber pad
007	70628	Schraube	Screw
008	70633	Gehäuse	Housing
009	70650	Chassis	Cartridge insert
010	70651	Frontplatte	End cap insert
011	70652	Tastaturmatte	Rubber button pad
012	70653	LED, rot	LED, red
013	70654	Buchse 3,5mm S	Jack 3.5mm s
014	70681	Buchse MINI DIN 6pin	Jack MINI DIN 6pin
015	70721	Adapter Klinke 3,5mm/2xCinchbuchse rot/weiss	Adapter jack 3,5mm/2xcinch socket red/white
016	70723	Adapter Klinke 3,5mm/2xCinchbuchse grün/gelb	Adapter jack 3,5mm/2xcinch socket green/yellow
017	70730	Bezeichnungsschild	Type plate
ZZ010	70682	Faltschachtel LUCAS	Folding box LUCAS
ZZ011	70683	Einsatz LUCAS	Insert LUCAS
ZZ012	70688	Zuschnitt	Cut insert
ZZ020	72148	Bedienungsanleitung LUCAS	Instructions for use LUCAS